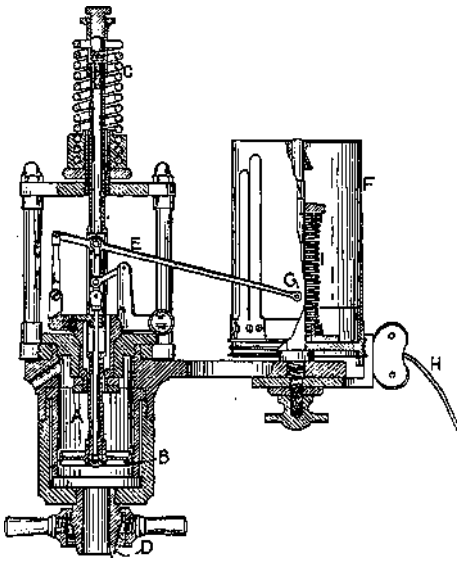
to adiabatic expansion in the ideal engine with a perfectly non-conducting cylinder.

The instrument called the indicator, by which a graphical record of the cyclic variation of pressure in a steam cylinder is made, was invented by Watt. He used a board upon which a sheet of paper was fixed, the board being given a to-and-fro movement less in extent but exactly proportional at all points to the movement of the piston. A small steam cylinder containing a piston loaded with a spring, the rate of compression of which was accurately known, was fixed in such a way that the movement of the piston was at right, angles to the direction of movement of the board. A pencil was fixed to the piston-rod, and on steam being admitted from the main cylinder to the under side of the indicator piston the latter moved in such a way as to cause the pencil when applied to the paper to trace a curve which at any instant showed the pressure of the steam in the engine cylinder. The height of the diagram traced depended of course upon the relation of the force exerted by the spring to the area of the indicator piston.



The area of the diagram thus represents the quantity of work performed during one stroke of

the engine, the method usually adopted being to find the mean pressure from the diagram and multiply this by the area of the engine piston in square inches and by the length of the stroke in feet, the product giving the number of foot-pounds of work developed during the stroke.

Fig. 3.-Crosby indicator

In the modern indicator the sliding board is replaced by a drum, to which is given a rotary to-and-fro movement by a cord attached at one end to a part which repeats the motion of the crosshead on a reduced scale, the other end of the cord being alternately wound and unwound on and from the drum, the motion of which is controlled by a clock-spring. The paper is wrapped round the drum and kept in position by two spring clips. A metallic pencil is used, for which the surface of the paper is specially prepared.

Fig. 3 shows the instrument manufactured by Messrs. Crosby & Co., Ltd. A is a small cylinder; B an accurately fitted piston, having an area of usually i sq. in.; c the spring; D a joint, by means of which the instrument can be attached to the-cock on the engine cylinder; E a straight-line mechanism, by which the movement of the piston B is repeated on an